ATTACHMENT B

Engineering Research and Development Center,
Corps of Engineers Waterways Experiment Station –
Results of Navigation Study for Port Manatee, Florida

DEPARTMENT OF THE ARMY
ENGINEER RESEARCH AND DEVELOPMENT CENTER, CORPS OF ENGINEERS
WATERWAYS EXPERIMENT STATION, 3909 HALLS FERRY ROAD
VICKSBURG, MISSISSIPPI 39180-6199

REPLY TO
ATTENTION OF

CEERD-HN-N (1110-2-1150a)

23 JUN 2000

COASTAL AND HYDRAULICS LABORATORY
Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

COLD REGIONS RESEARCH AND ENGINEERING LABORATORY
72 Lyme Road
Hanover, NH 03755-1290

CONSTRUCTION ENGINEERING RESEARCH LABORATORY
P.O. Box 9005
Champaign, IL 61826-9005

ENVIRONMENTAL LABORATORY
Waterways Experiment Station
3909 Halls Ferry Road
V[illegible], MS 39180-6199

GEOTECHNICAL LABORATORY
Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

INFORMATION TECHNOLOGY LABORATORY
Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

STRUCTURES LABORATORY
Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

TOPOGRAPHIC ENGINEERING CENTER
7701 Telegraph Road
Alexandria, VA 22315-3864

MEMORANDUM FOR Commander, U.S. Army Engineer District, Jacksonville,
ATTN: CESAJ-EN-HI (Mr. Mike Choate),
P.O. Box 4970, Jacksonville, FL 32232-0019

SUBJECT: Final Report for Port Manatee Navigation Study

1. The navigation study of Port Manatee is complete and the final report is enclosed. Your office has been furnished the composite track plots under separate cover because Tampa Bay Pilots Association considers track plots to be their intellectual property. They have requested that copies of these track plots be limited to your office and the Manatee County Port Authority. However, you have unlimited distribution of the attached final report.

2. If there are any questions concerning this study, please contact Mr. Dennis W. Webb (601/634-2455).

Encl

THOMAS W. RICHARDSON
Acting Director
Coastal and Hydraulics Laboratory

CF:
Capt. Jorge Viso
Tampa Bay Pilots Association
5103 Westshore BLVS
Tampa, FL 33611

Results of Navigation Study of Port Manatee, FL

Introduction

Port Manatee (Figure 1) is located on the southeast side of Tampa Bay. It is Florida's fifth largest port. The Port Manatee Channel, which connects the port with the Tampa Bay Channel, is 400-ft wide and 40-ft deep. The Tampa Bay Channel is 40 ft deep and 500 ft wide at its intersection with the Port Manatee Channel. Both bulk and containerized cargo presently move through the port. Loaded ship movements are restricted to near slack water (currents less than 0.2 knots[1]) due to the strong crosscurrents in Manatee Channel. These crosscurrents are a particular problem for ships turning between Manatee and Tampa Bay Channels.

The U.S. Army Engineer District, Jacksonville (CESAJ) has proposed several channel improvements for Port Manatee (Figure 2). The bend widener at the intersection of Manatee and Tampa Bay Channels was designed so ships could make the turn during strong tidal currents. Two additional improvements, a 1,400-ft diameter turning basin and an access channel, are proposed to accommodate a new cruise ship dock. This plan was referred to as Plan A. Figure 3 is an aerial photo of present day Port Manatee. Figure 4 is an artist's rendering of the future Port Manatee after construction of the cruise ship dock.

In order to evaluate these proposed improvements, the U.S Army Research and Development Center, Coastal and Hydraulics Laboratory (CHL) conducted a ship simulator based navigation study from September to December 1999. Ship pilots licensed for Port Manatee operated the simulator in "real time".

Modeling Approach

CHL conducted an earlier navigation study for Port Manatee in 1989. The visual scene, channel, current and radar databases for that simulation were used for this study. These databases were updated to include the proposed channel improvements. Figure 5 shows the strong ebb and flood crosscurrents validated during the 1989 study.

Two design ships, a cargo and a cruise ship, were used during the current Port Manatee navigation study. The *El Gaucho*, a 775-ft long cargo ship, with a beam of 106 ft was loaded to 36-ft draft. The cruise ship was modeled after the *Disney Magic*, a 965-ft long by 106-ft beam cruise ship. The *Disney Magic's* draft was 26 ft.

The simulation models were validated during 8--10 November 1999. During validation, the simulator databases (channel, current, ship, visual, and radar) are checked out to ensure realism. If necessary, the models are adjusted until vessel response is correct. Two pilots from the Tampa

[1] Tampa Bay Ports Guide, 1999 "Recommended Handling Guidelines for Vessel Movement in Tampa Bay," Tampa Bay Pilots Association, Page 16

Bay Pilots Association and one pilot from the Canaveral Pilots Association (Port of Canaveral, Florida) participated in the validation. The Canaveral Pilot was included because the *Disney Magic's* home is Port Canaveral. The Port Manatee Director of Engineering and the naval architect who developed the numerical ship models also attended validation.

The *Disney Magic* has a forward bridge, severely limiting visibility astern. Also, the helm is not very high above the deck, limiting view of the water surrounding the ship. Special care was taken during validation to ensure that visibility from the simulation of the *Disney Magic* was similar to that in real life. Figure 6 and 7 show a comparison between the real life view and the simulator view.

During validation, the simulation of ships turning between Tampa Bay Channel and Port Manatee Channel was conducted numerous times. As a result of those runs, the southern portion of the Plan A widener was modified with input from the pilots. The new proposed channel improvements, Plan B, became the test channel for the formal simulation program. Plan B is shown in Figure 8.

Simulation Program

The formal simulation program for Port Manatee was conducted from 6-14 December 1999. Six pilots participated in the testing program. The pilots traveled in pairs to Vicksburg for two days of testing per pair. Port Manatee was represented by both the Director of Engineering and Director of Maritime Marketing during portions of the testing program. A representative of CESAJ also attended a portion of the testing program.

During the first testing session two important issues became apparent. First, due to the *Disney Magic's* limited view astern, outbound ranges were added to the visual and radar databases. Second, the environmental conditions being tested were too severe for the runs to be successfully completed. The pilots were having difficulties with both ships for the extreme maximum tidal currents. The extreme maximum tidal currents were cut in half to represent a typical maximum current magnitude. Simulation exercises were conducted with both the extreme and typical maximum currents. The pilots were also having problems handling the *Disney Magic* in the strong wind. The *Disney Magic*, with its high freeboard, was extremely sensitive to the wind, while the *El Gaucho*, loaded to a draft of 36 ft, was not. Therefore, simulation runs of the *Disney Magic* with the wind reduced from 15 to 10 knots were added to the testing program.

The pilots could not stop their ship in the turning basin on several runs, and consequently, hit the dock. This occurred due to an intermittent problem with the ship simulator databases, and is neither pilot error nor a design flaw in the turning basin. Not every pilot experienced this problem, nor did the pilots experience it every time they ran the turning basin scenarios. The pilots that experienced the problem felt that the ship handled realistically prior to the ship entering the turning basin. Therefore, results from that portion of those runs are included in the analysis in this report. The pilots, who did not experience any problems slowing their vessel, felt that the turning simulations were accurate.

tests of the turning basin, without making a complete run. Five of the six runs that made the turn from Tampa Channel did so without incident. One pilot delayed his turn and clipped both sides of the channel. This shows a significant improvement over the runs conducted with maximum flood tide. Once the turn was made, none of the vessels left Manatee Channel until they reached the turning basin. Two of the ships had their bow out of the northern portion of the channel by approximately 10 ft. One pilot could not stop his ship in the basin and his run was aborted just prior to hitting the dock.

Six outbound transits were conducted with the *Disney Magic* at maximum ebb tide and 10 knots of wind from the northeast. All of these runs left the south side of the channel due to the combination of wind and ebb tide crosscurrents. The average crab angle for the ships near the northwest end of Manatee Channel was approximately 20 degrees to the east. This caused one ship to completely leave Tampa Channel while turning from the Manatee Channel.

Six runs were conducted with the *Disney Magic* outbound, with typical ebb tide and 10 knots of wind from the northeast. All runs were able to remain in the Manatee Channel. The typical crab angle was about 10 degrees to the east, or half the typical crab angle of the maximum ebb tide runs. One ship entirely left Tampa Bay Channel while making the turn out of Manatee Channel because the pilot waited too late to make the turn.

Seven tests, with the *Disney Magic*, outbound at maximum flood tide, with 10 knots of wind from the southwest were conducted. One of the ships left the south side of Manatee Channel. The remaining six ships stayed within Manatee Channel until reaching the turn to Tampa Bay Channel. One ship left the south side of the channel at the entrance to the bend widener. Another ship left the bend widener on the north side.

Four transits of the *Disney Magic*, outbound with typical flood tide and 10 knots of wind from the southwest were made. One of the runs left the south side of Manatee Channel while holding against the currents. The remaining three runs stayed within the channel. All four runs successfully made the turn into Tampa Channel.

El Gaucho Evaluation of Track Plots. Three simulation runs of the *El Gaucho* were conducted for maximum ebb tide and 15 knots of wind from the northeast. One run failed to make the turn after being swept into the southern portion of the bend widener by the currents. Both vessels that successfully turned into Manatee Channel left the authorized channel shortly after making the turn.

Four inbound transits of the *El Gaucho* were conducted with typical ebb tide and 15 knots of wind from the northeast. All runs were successful.

2. The proposed widener improved the turn between Tampa Bay Channel and Manatee Channel significantly. Figure 9 is a composite of selected turns through the widener. The composite is composed of both the *Disney Magic* and *El Gaucho*, inbound and outbound, ebb and flood with the appropriate wind direction. Transits that were in a bad position due to the environmental conditions prior to entering the turn are not shown in this figure. The tracks fit the widener fairly well, with the following observations. None of these runs came within 300 ft of middle of the southern leg of the widener. Numerous runs left both sides of the western end of Manatee Channel, both leaving and approaching the widener.

3. The bend widener between the Manatee and Tampa Channels was proposed to eliminate tide restrictions at Port Manatee. However, the simulator results clearly indicate that the existing 400-ft wide Manatee Channel is not wide enough to support traffic throughout the tidal cycle because the western end of Manatee Channel is perpendicular to the currents. A portion of two track plots is shown in Figure 10. Both outbound simulations with ebb tide and wind from the northeast were conducted with the same pilot. One run was with the maximum ebb and the other with typical ebb. This figure illustrates how much of channel width is actually occupied by a ship being subjected to strong side forces. The effective beam of the maximum ebb ship is nearly 300 ft, while the effective beam of the typical ebb ship is 225 ft. Possible solutions to this problem include significant widening or re-orienting Manatee Channel.

4. The proposed 1,400 ft turning basin is adequate in size. However, the turning basin would be better located on the centerline of Manatee Channel (Figure 11). Not requiring the ships to pull over into the basin should result in time and tug usage savings for all vessels calling at Port Manatee.

5. Outbound ranges are necessary for better ship positioning in the Port Manatee channel.

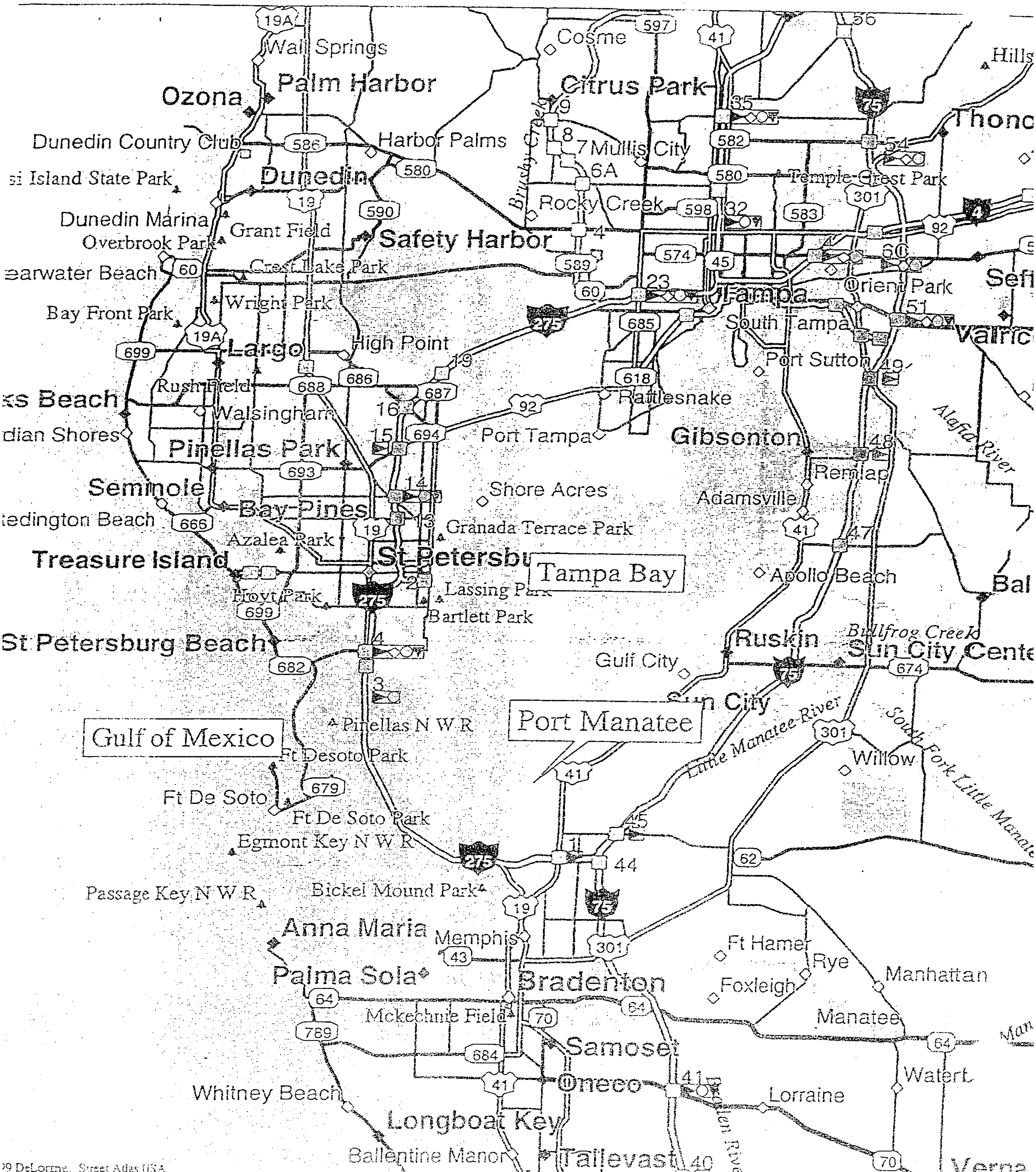
Recommendations

1. The Plan B bend widener between Tampa Bay and Manatee Channels will provide better relief from the tide/wind restrictions presently imposed on Port Manatee, and may be constructed as tested. Modifications to that widener (Plan C) that should allow even further easing of restrictions are shown in Figure 12. Both sides of the western end of Manatee Channel have been widened 100 ft to accommodate ships transiting in stronger crosscurrents.

2. The 1,400 ft turning basin is adequate for turning large cruise ships, and may be constructed as tested. However, a turning basin centered on Manatee Channel would better serve the Port of Manatee, as previously stated in the conclusions.

3. The outbound ranges for Manatee Channel are strongly recommended. The U.S. Coast Guard district in Miami is responsible for navigation aides for Port Manatee and should be furnished this report.

Figure 1. Port Manatee Location Map



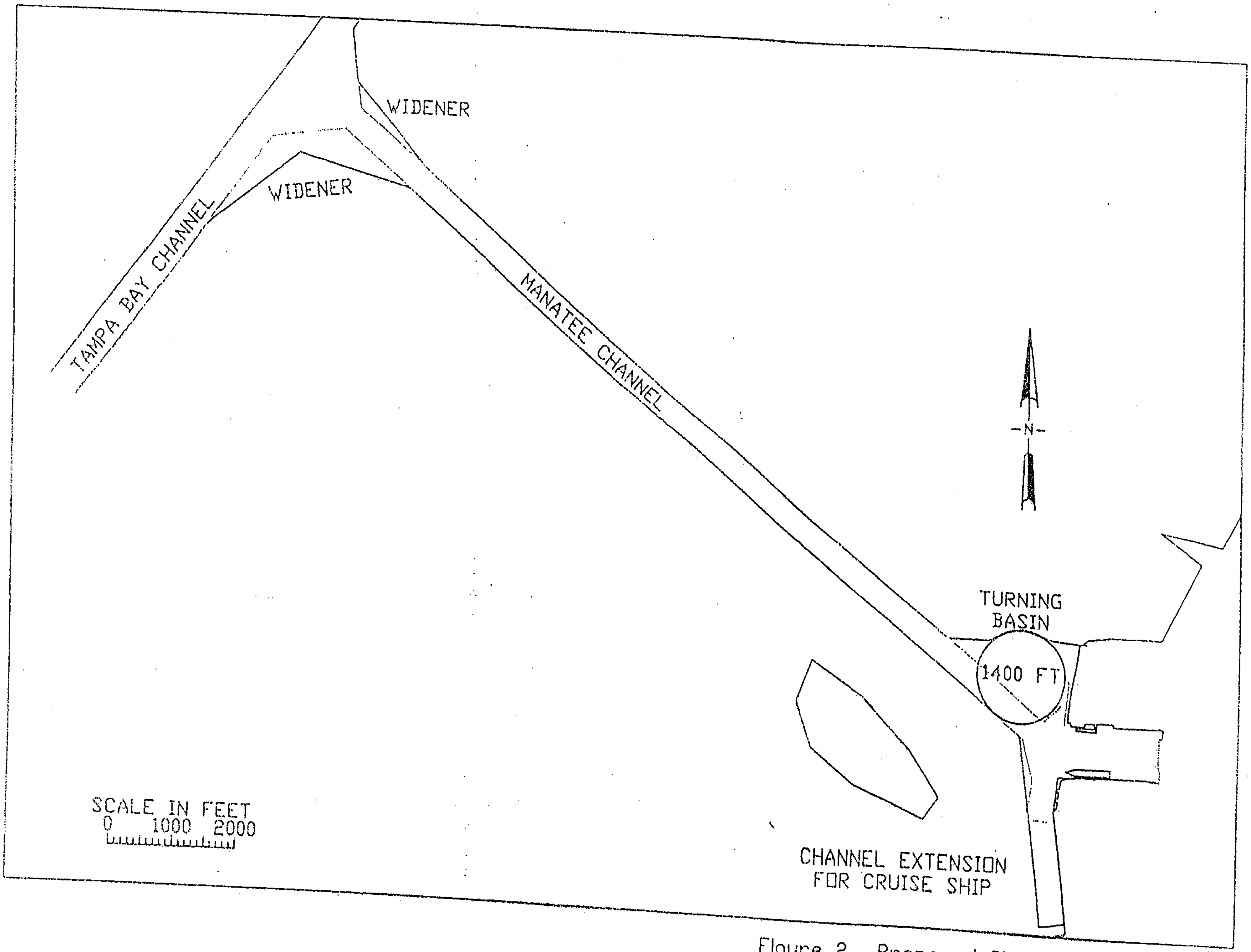


Figure 2. Proposed Channel Improvement-

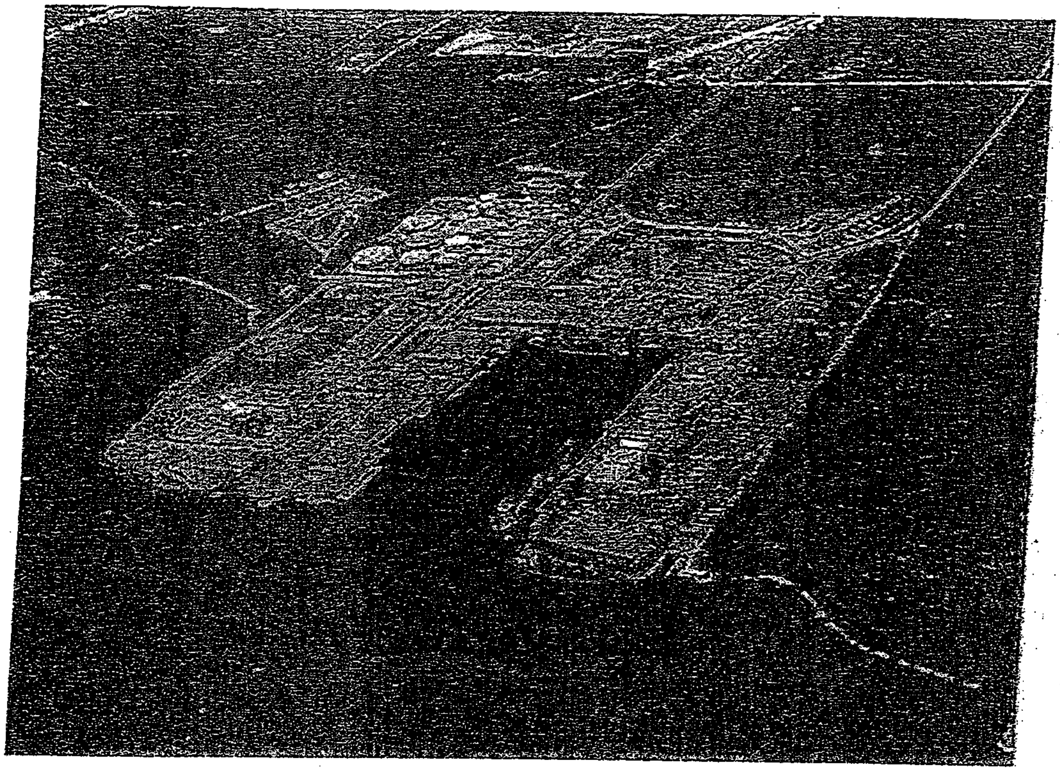


Figure 3. Aerial View of Port Manatee

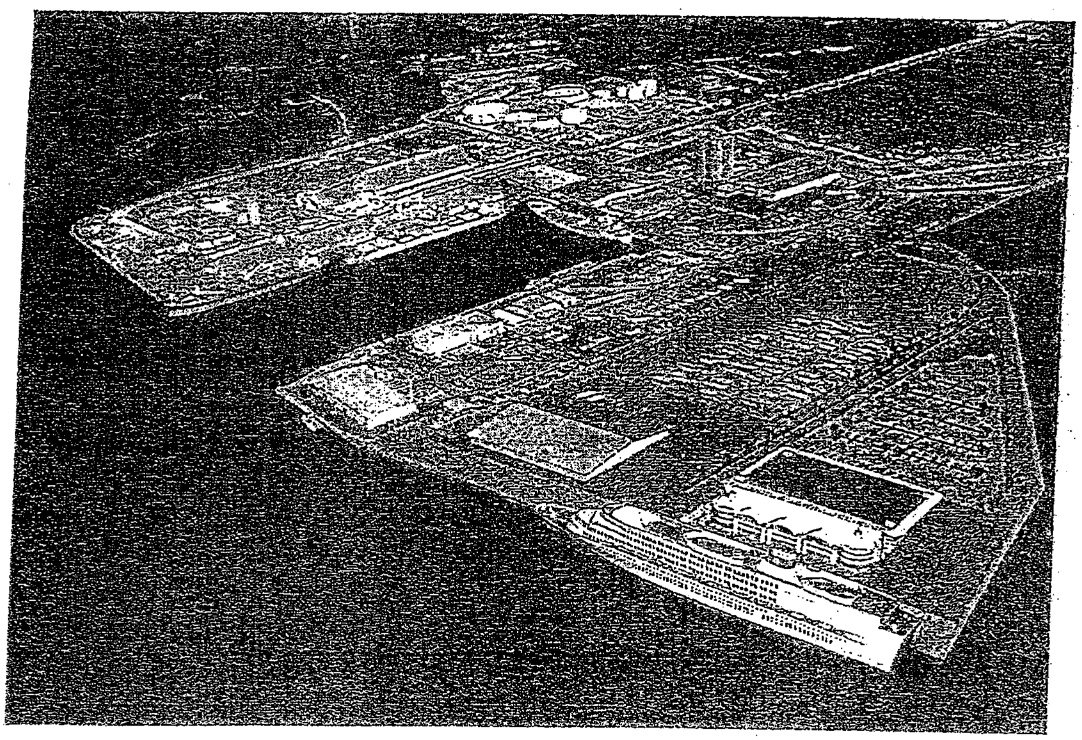


Figure 4. Artist Rendering of Proposed Cruise Ship Dock

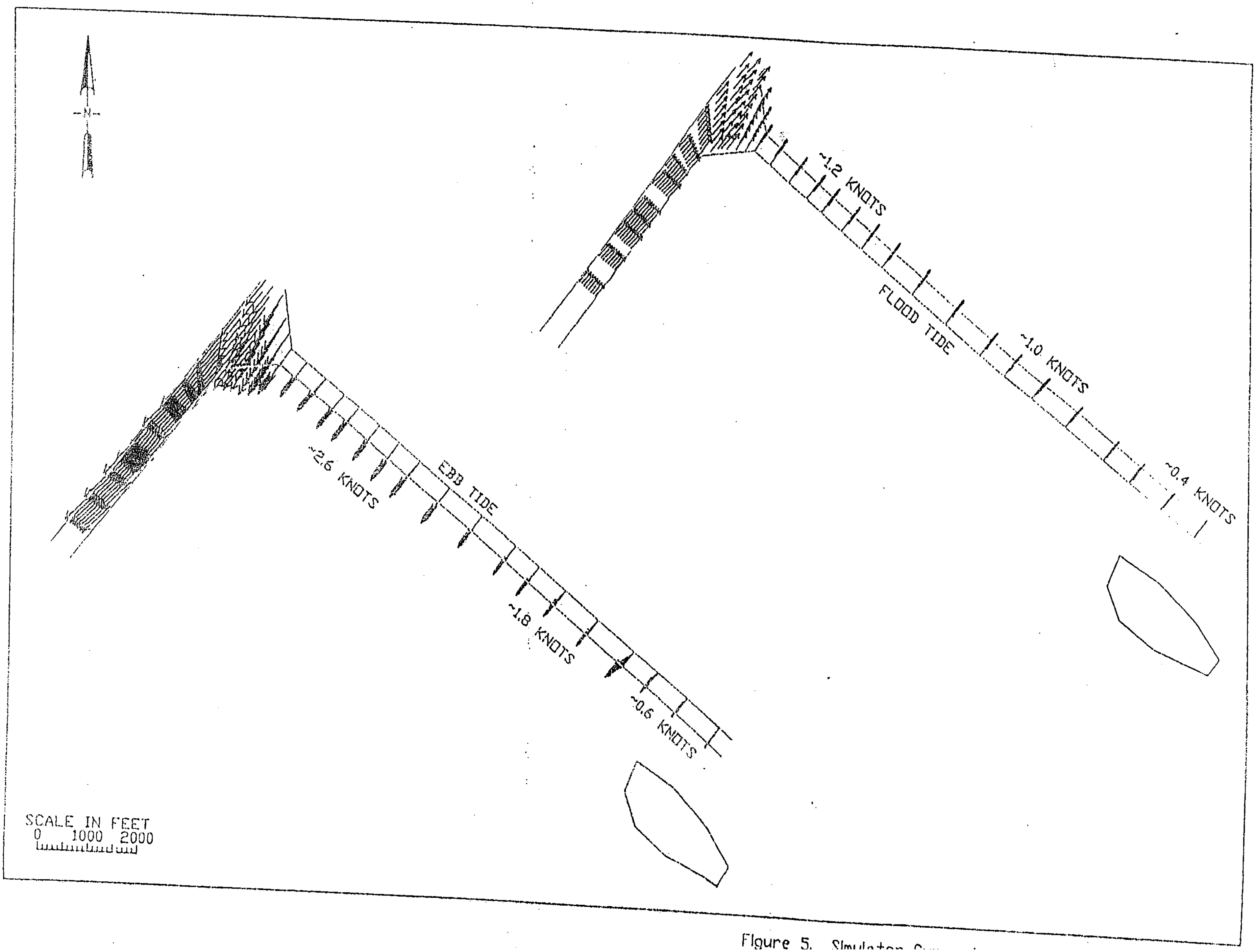


Figure 5. Simulator C...

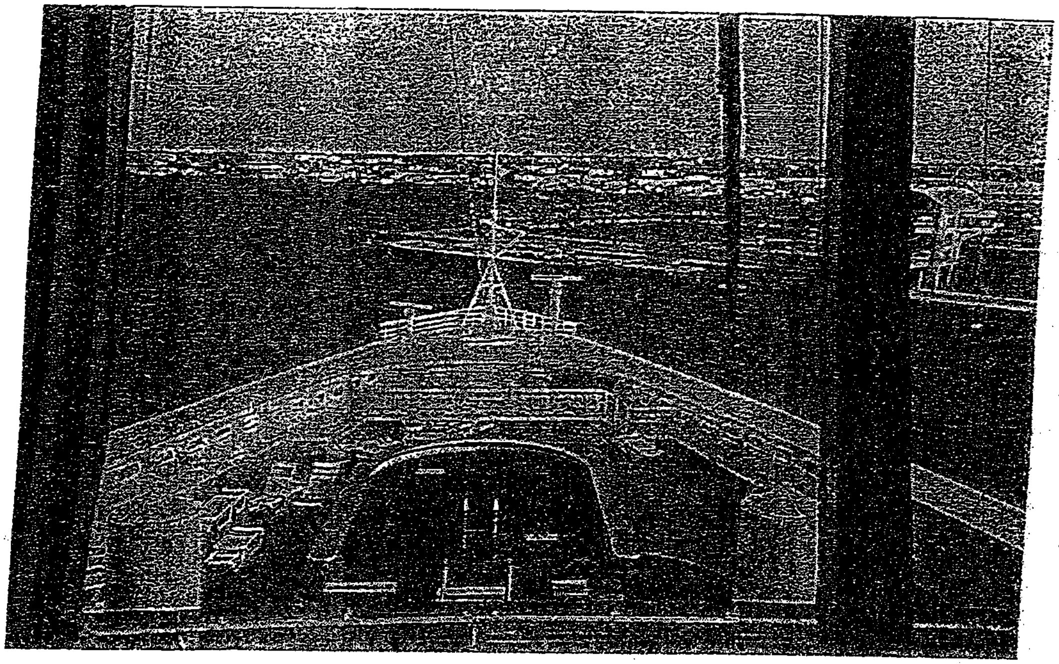


Figure 6. View from *Disney Magic's* helm

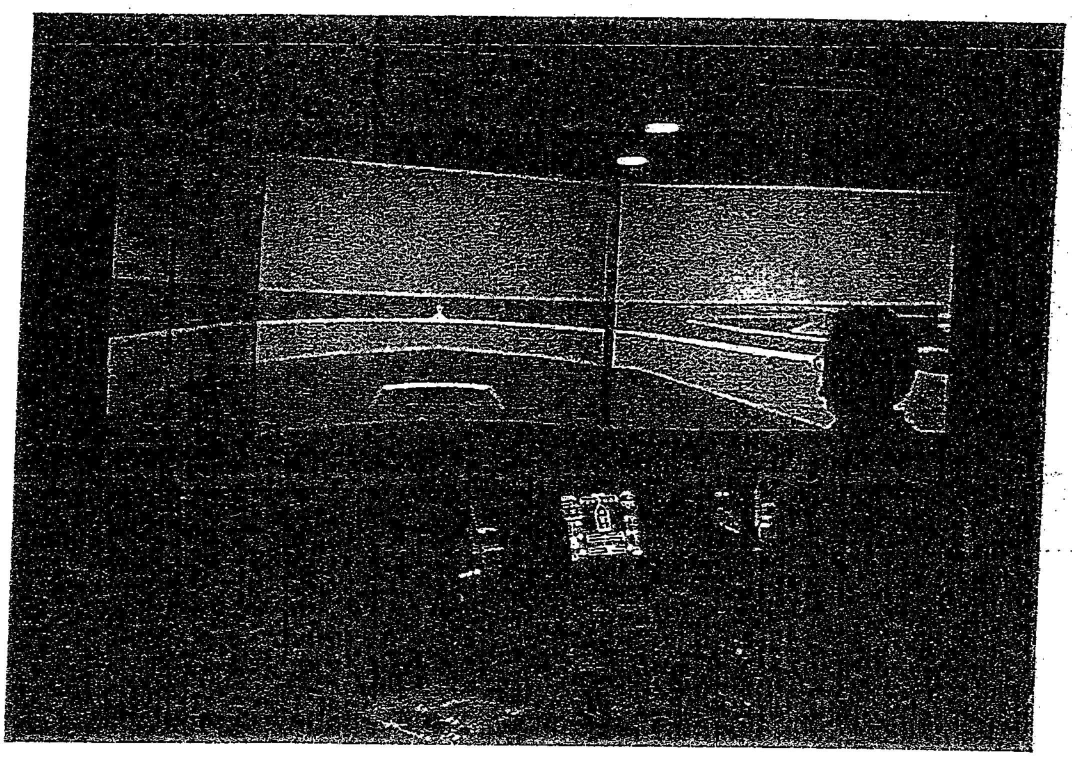


Figure 7. *Disney Magic*, Simulator View

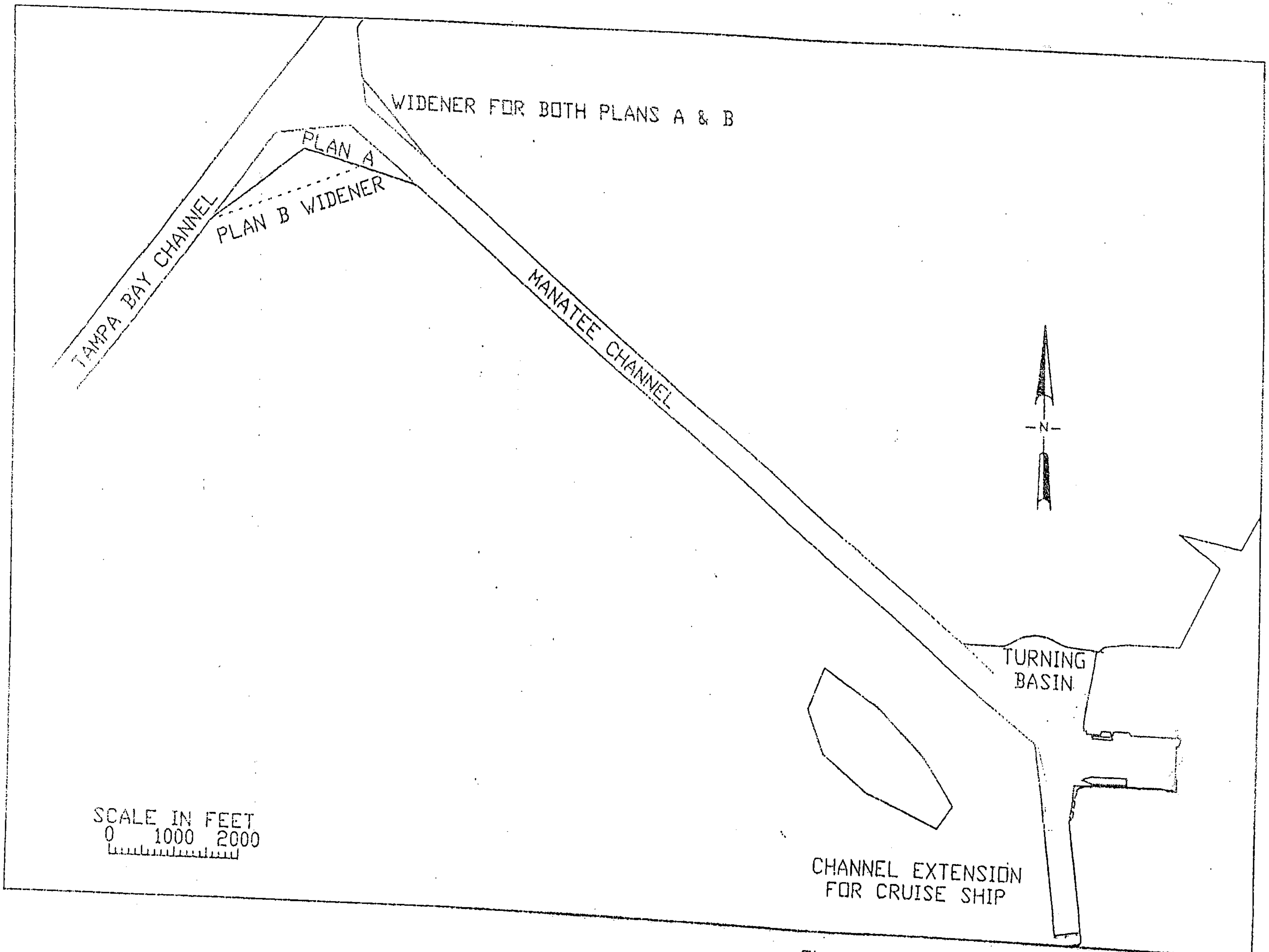


Figure 8. Plan B Channel Improvements

Figure 9. Bend Widener all runs

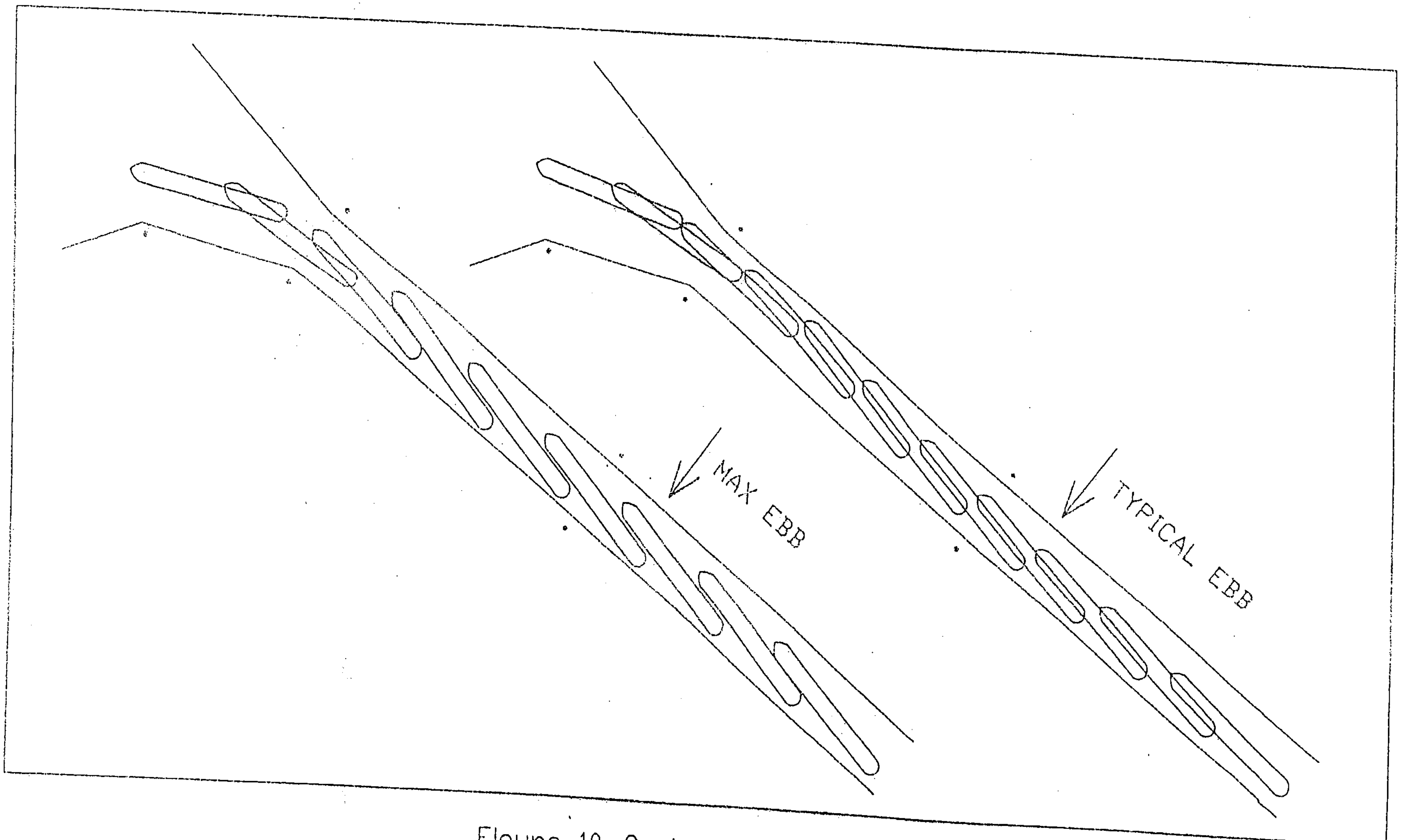


Figure 10. Crab angle comparison, Maximum and Typical

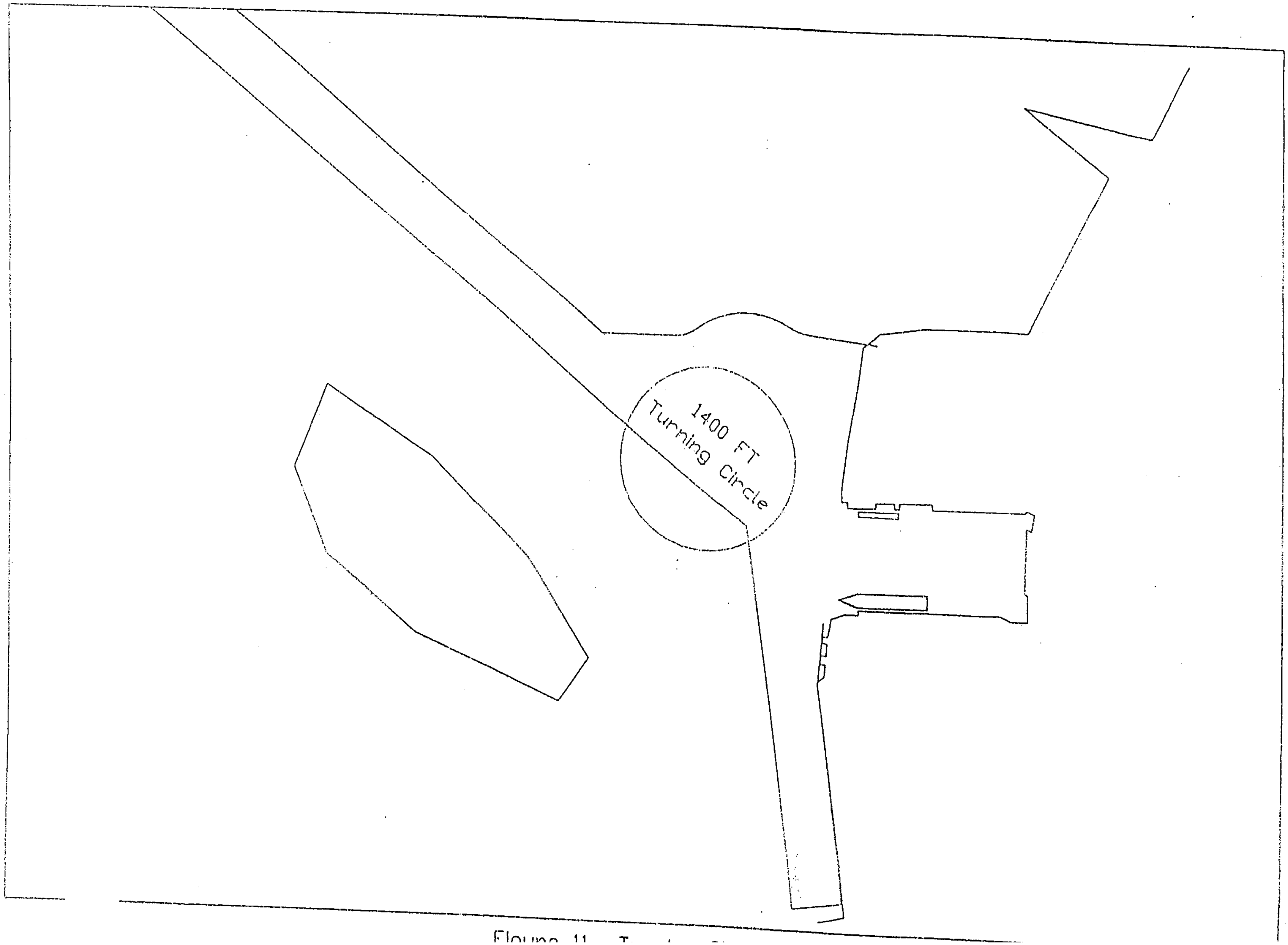


Figure 11

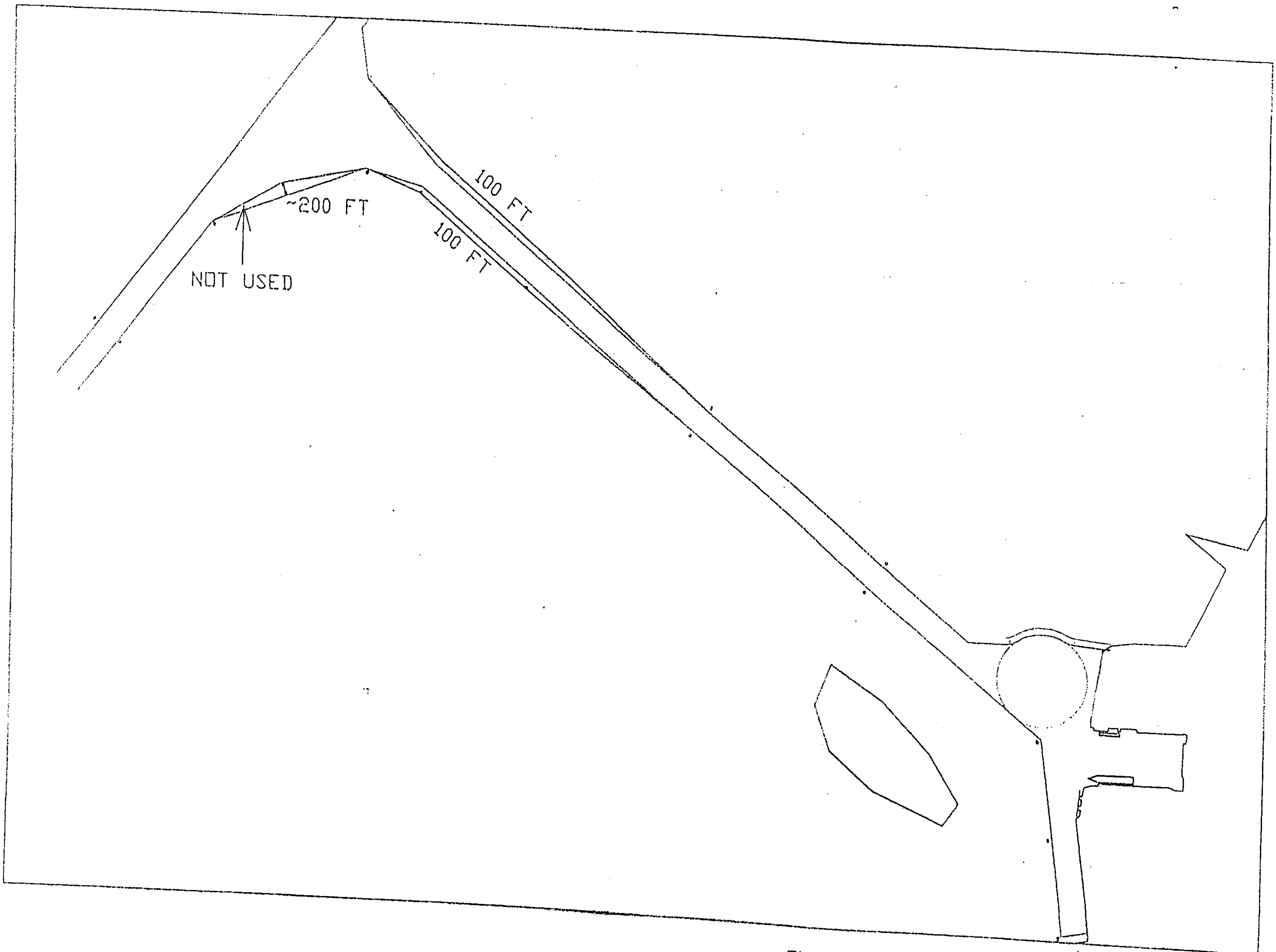


Figure 12. Proposed Improvments Plan